ALEX EAGLES

SUAS COMPETITIONS

MEGA PROJECT
AUTONOMOUS TEAM
TEAM 2
TASK 4

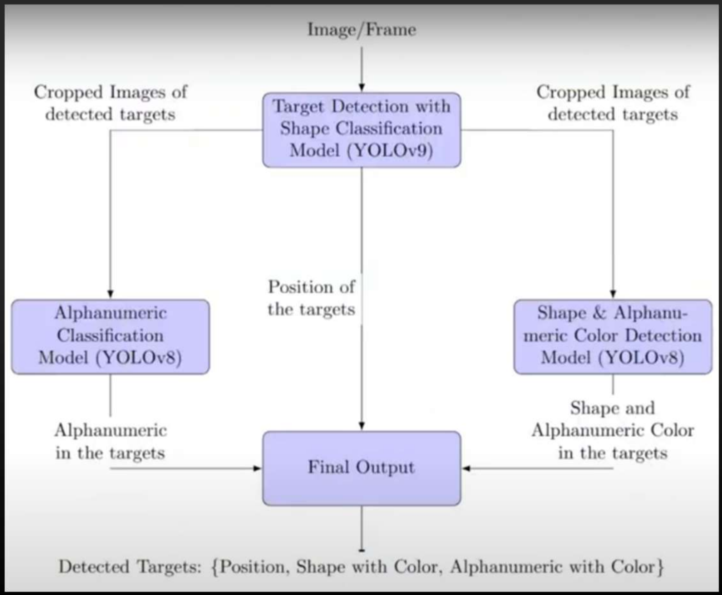
TABLE OF CONTENTS

UAS2030 King Fahd UNIVERSITY

ODLC (Object Detection, Localization, and Classification) Pipeline

Their ODLC system combines high-resolution image capture, real-time LIDAR scanning, and advanced deep learning algorithms (YOLO) to accurately detect, localize, and classify targets. By leveraging data synthesis and augmentation, they ensured robust model training, allowing their system to handle various environmental conditions and target characteristics with high accuracy.

- **Data Acquisition:** The drone captures high-resolution images using the Basler A2 camera mounted on a passive gimbal. This stabilizes the camera, especially when the drone is moving, ensuring that the captured images are sharp and usable for analysis.
- **Object Detection:**
  - The RPLIDAR A2 sensor updates every 100 ms and is positioned at the top of the drone to provide a 3D environmental awareness to help detect and map objects in the drone's surroundings.
  - They employed the **bendy roller algorithm**, which is a path-planning to help the drone in identifying and classifying objects or targets by guiding how the LIDAR data is processed.
- **Target Detection:** They used three YOLO (You Only Look Once) models:
  1. YOLOv9 was used in identifying target and Shape classification:
  2. Then YOLOv8 was trained for identifying Alphanumeric characters
  3. The other YOLOv8 model was trained for Color detection.

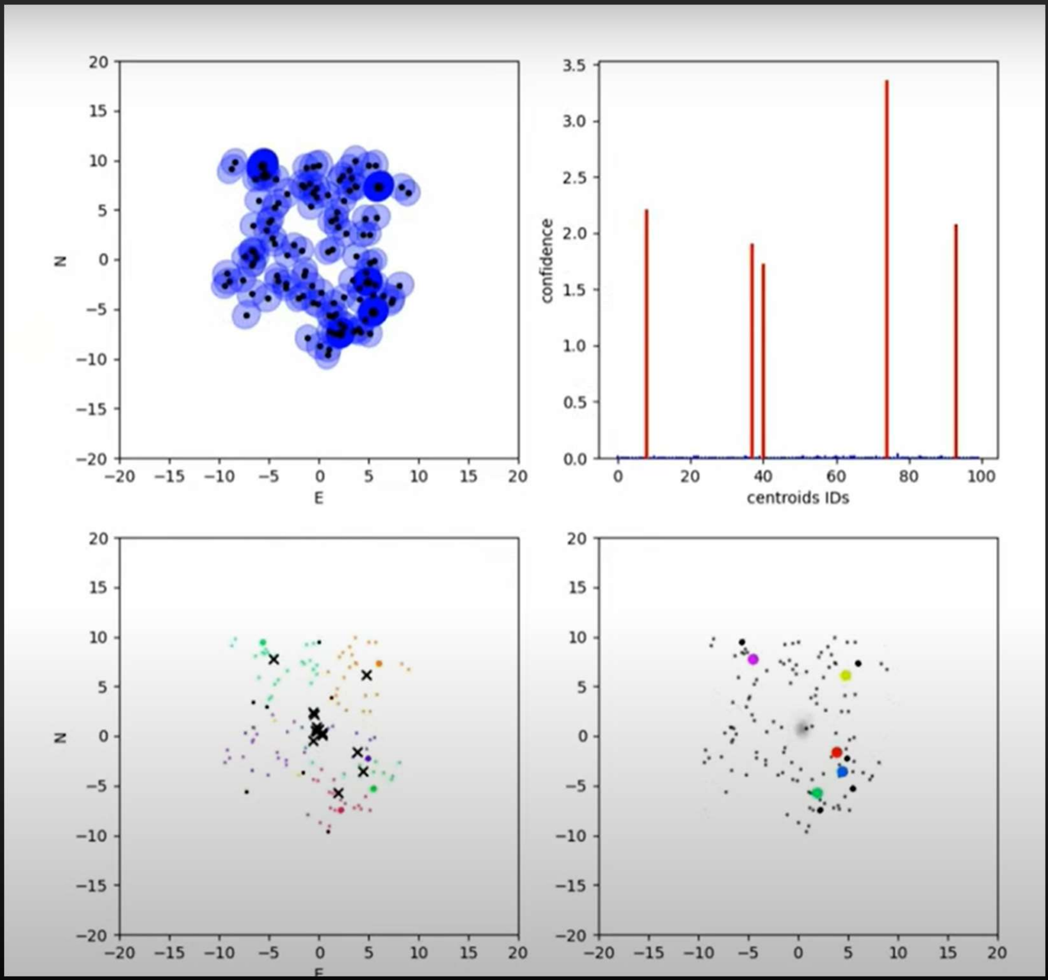


- Data Synthesis for Training: A synthetic dataset of 53,000 images is created using Blender which was further augmented with various **transformations** (e.g., rotations, scaling, and flipping) and added **noise** then rendered on backgrounds that were captured by the drone.

Localization:

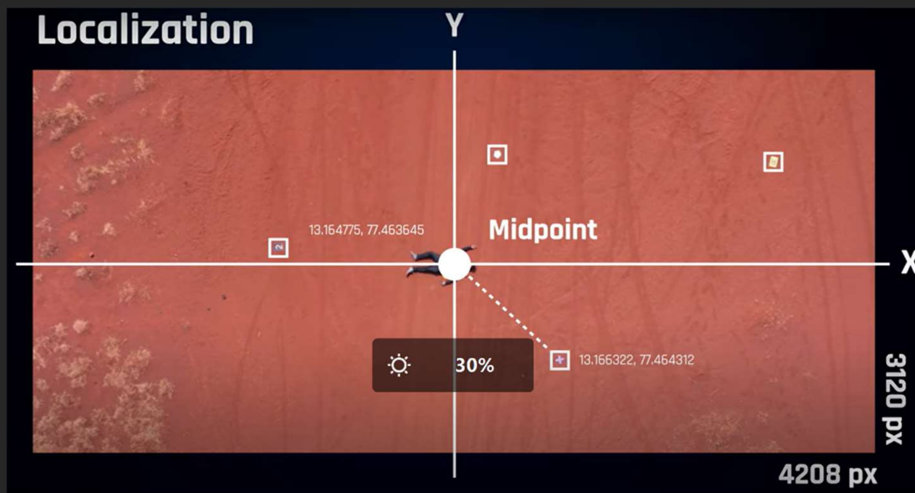
Since this team did not provide a clear description of how they implemented localization, we will discuss the localization of another team (**Sapienza Flight Team, P8-NB8).**

They used GeoGebra software to determine the location of the targets by considering variables such as the position longitude, latitude and altitude of the UAV and the position of the camera relative to it. This result in low lens deformation compared to measurement errors. In addition, they used Geolocation to provide estimates and measurements errors using methodologies such as Monte Carlo and Maximum Likelihood Estimation on each sample target resulting in an empirical error of 16 inches



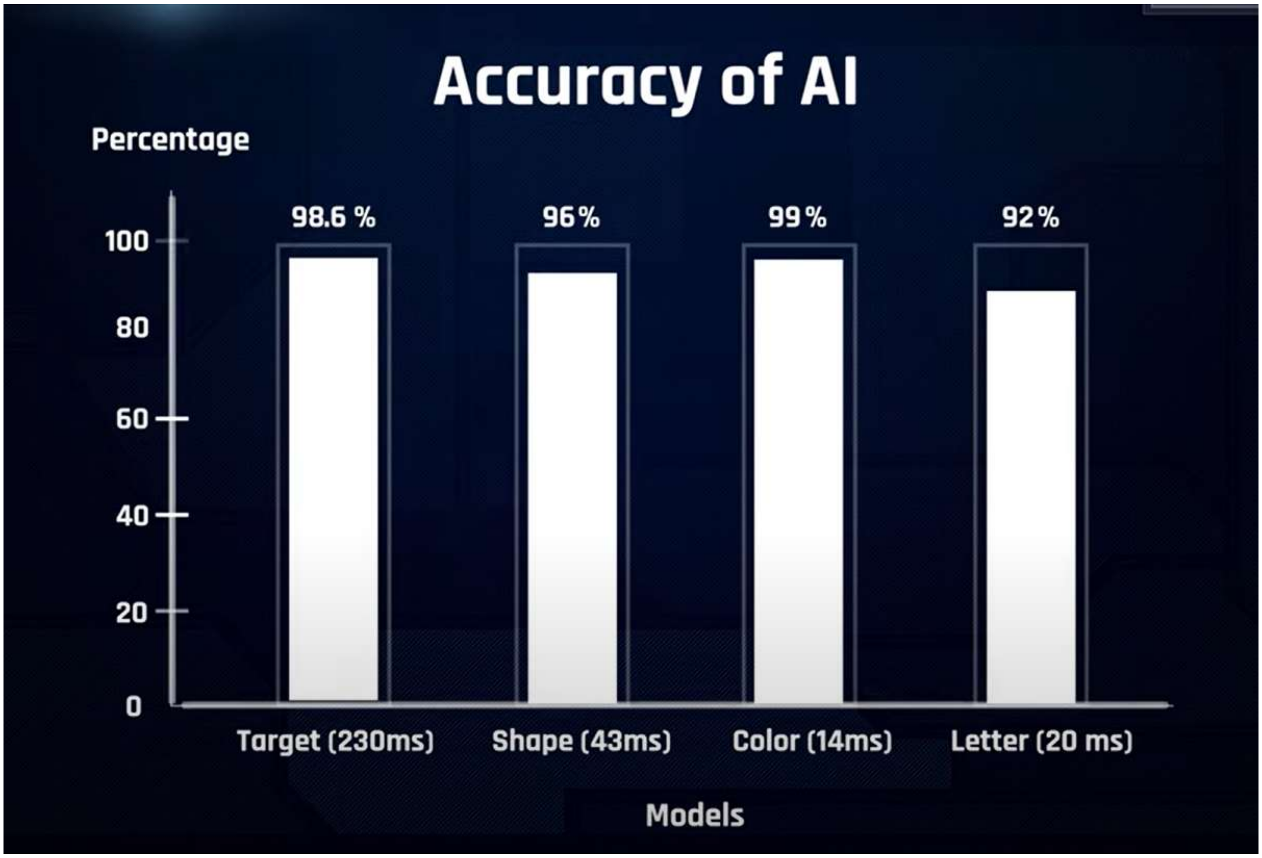
Localization by Edhitha UAS:

Cropped image meta data holds results matching GPS to image timestamp gives desired target coordinates for calculating intended location for Localization.



After AI inference a pop up UI in the UI shows target attributes. The operator can log the target and activate the drone from autonomous drop and mission. For our AI contingency plan they have created a GUI with direct drone control.. Operator can hold and move the drone by selecting objects in the GUI using real time pixel coordinates.

Accuracy of AI models results:

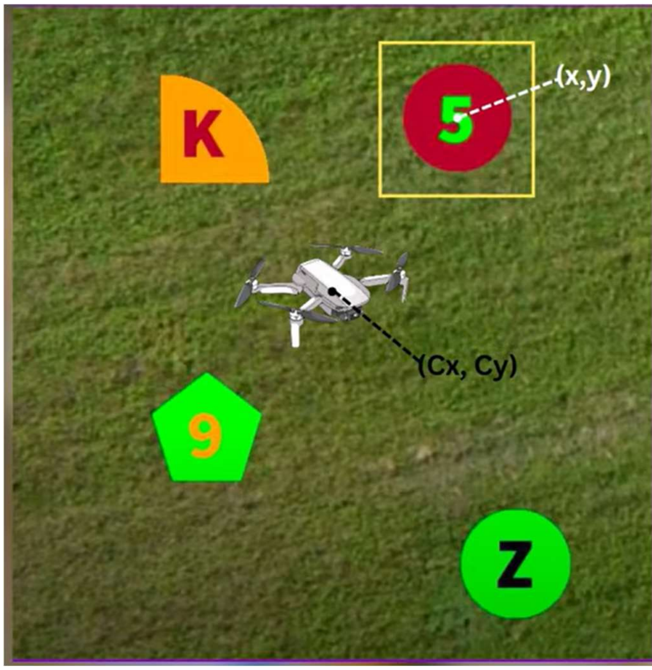


AI Test Cases

Altitude	Pixel Resolution	Footprint	GSD	Accuracy of models	Lighting condition
100 ft	70 x 80	12 x 9	0.21	95	midday
				93	overcast
120 ft	100 x 80	14 x 11	0.26	92	midday
				89	overcast
140 ft	160 x 90	17 x 13	0.39	97	midday
				92	overcast

Localization by Alex Eagles Team:

Localization was achieved using camera and GPS module and the latitude and longitude of the target is obtained by measuring the target's distance in pixels from the image's center using the camera's 21mm focal length. They were able to convert this distance into meters. Then into GPS coordinate using the following equation



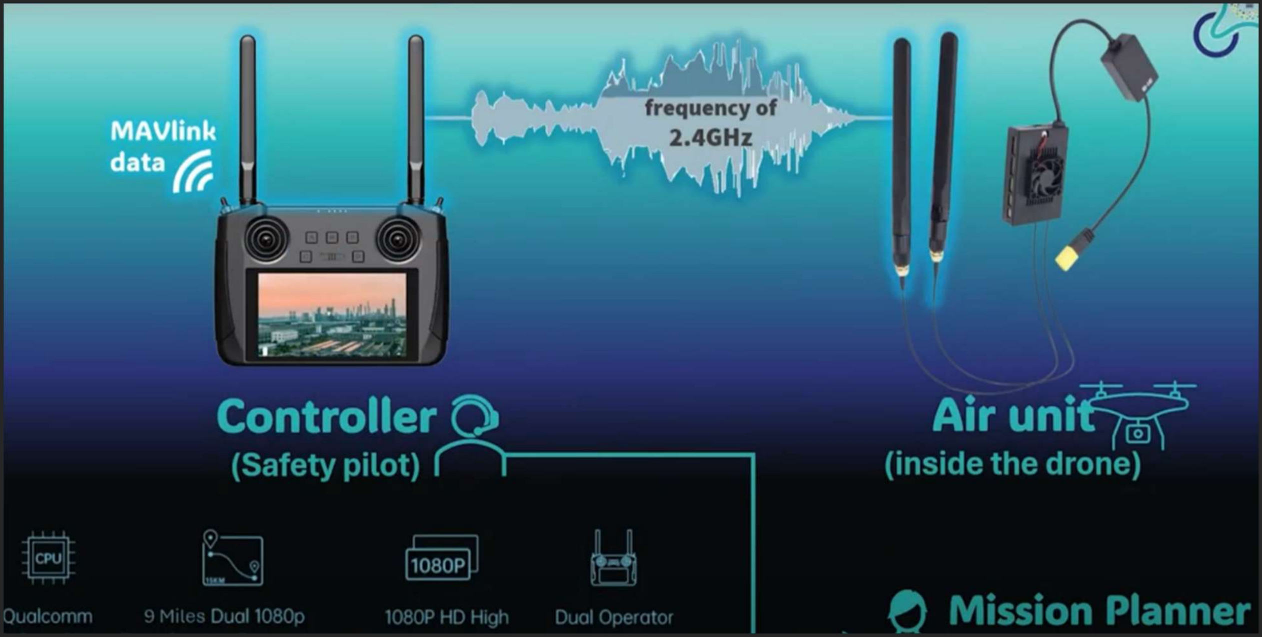
$$X = Altitude * (\frac{x - c_x}{f_x})$$

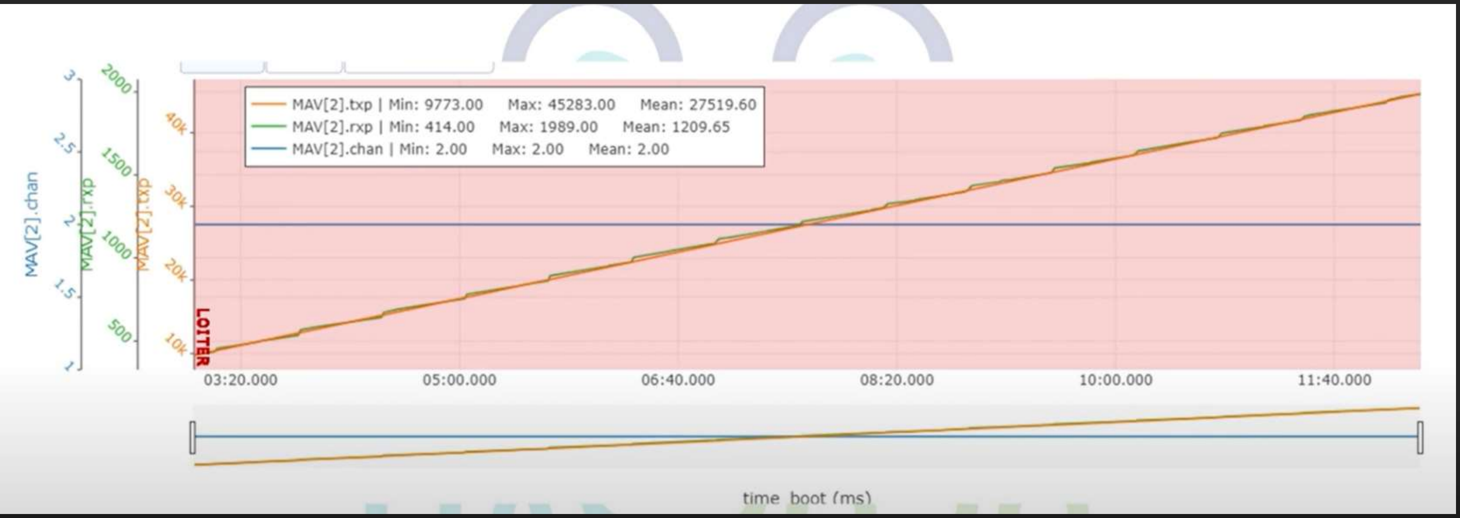
COMMUNICATION SYSTEMS

The team set up a robust and reliable communication infrastructure between the UAV and the GCS, ensuring real-time data transfer and stable video streaming over long distances.

First of all, they used Cube Orange Plus autopilot system equipped with advanced IMU and an H7 processor to handle flight controls. The Cube was also connected to the Here 3 GPS for navigation and localization.

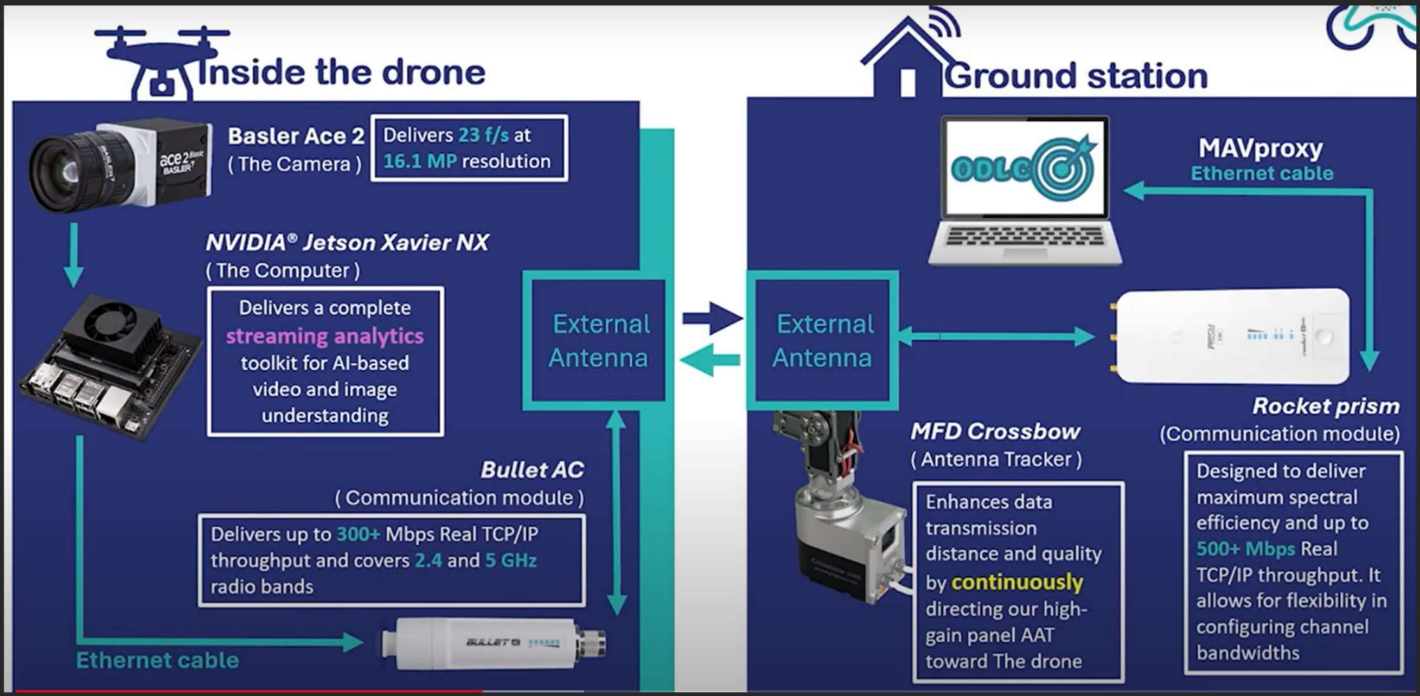
They used 2 wireless communication channels. The first one is using the Sui MK15 controller to transmit and receive MAVLink data between the UAV and the GCS. This controller had a range of over 9 miles, providing a reliable link for telemetry and control data. They have tested the speed of this communication link and the results where promising as shown below.



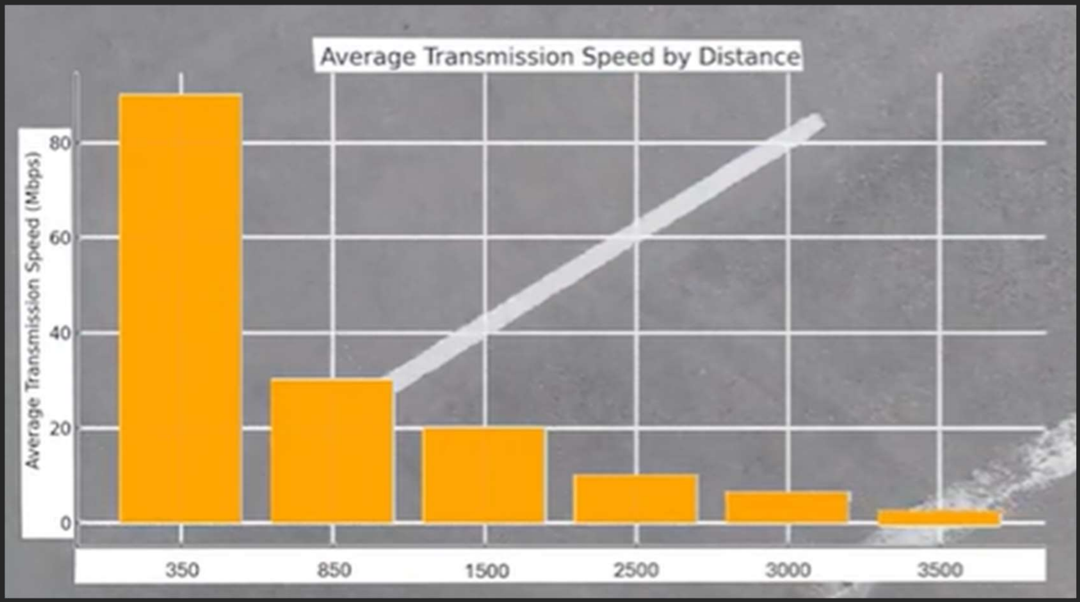


The second communication channel was used for streaming high-quality video, separate from the **MAVLink** data channel to ensure there was no interference between the two systems.

- For video streaming, they used a Bullet AC radio and wifi transmitter which delivers up to 300+ MPBps Real TCP/IP installed inside the UAV for long-range communication.
- On the ground station, they used a Rocket Prism connected to a unidirectional antenna, which provided complete coverage of the 5GHz spectrum.
- The operating frequency range for this system was 5,500-5,875 MHz, ensuring the link could be maintained over long distances with minimal interference.
- To maintain a stable connection, they used an MFD Crossbow tracker, which helped ensure the link stayed stable and reliable during flights.



To test the second communication line, they conducted a range test across 6 different distances using a 128Mb file to measure variations and data rates.



Type of Onboard Computer:

The onboard computer used was the **Nvidia Jetson Xavier**, a powerful AI computer known for handling real-time processing tasks, including video analysis and data computation.